MEASUREMENTS ON THE NUCLEAR PHOTOEFFECT AT ENERGIES BELOW 20 M.E.V.

BY
GEORGE CURRIDEN BALDWIN
B.A., Kalamazoo College, 1939
M.A., University of Illinois, 1941

AN ABSTRACT OF A THESIS
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
PHYSICS IN THE GRADUATE SCHOOL OF
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This problem was suggested by Professor Donald W. Kerst and carried out under his supervision. I am deeply indebted to him for the interest, helpful advice, and active assistance he has given in the course of this work.

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The nuclear photoeffect exhibits a sharp threshold, since the energy of an incident quantum must exceed the binding energy of the particle to be ejected. A knowledge of the binding energy is essential to a full understanding of nuclear structure, but until now satisfactory sources of sufficiently high-energy radiation have not been available for threshold measurement.

By using the x-rays from the betatron as disintegrating agents, photoeffect thresholds can be readily measured. Continuous control of peak energy is provided by a circuit which actuates the orbit expander[1] when a predetermined amount of flux has been linked with the electrons' orbit. Samples are irradiated at a sequence of energies and the induced radioactivity measured with a Geiger-Müller counter. When the activity is plotted as a function of peak energy, smooth curves result from which the threshold is found by inspection. The following thresholds have been measured:

Element Irradiated	Active Isotope	Half-life (minutes)	Threshold (M.E.V.)
Carbon	C^{11}	21	18.7 to 19.4
Nitrogen	N^{13}	10	11.1 ± 0.5
Oxygen	O^{15}	2.1	16.3 ± 0.4
Iron	Fe^{53}	9	14.2 ± 0.4
Copper	Cu^{62}	10.3	10.9 ± 0.3
Zinc	Zn^{63}	39	11.6 ± 0.4
Selenium	$Se^{79 \text{ or } 81}$	17	9.8 ± 0.5
Molybdenum	$Mo^{91 \text{ or } 93}$	17	13.5 ± 0.4
Silver	Ag^{108}	2.3	9.3 ± 0.5

The first three thresholds are to be compared with values of 18.75 ± 0.2, 10.65 ± 0.15, and 15.6 ± 0.6 M.E.V., respectively, computed from mass and disintegration data. The agree-

1. Kerst, Rev. Sci. Inst. **13**, 387 (1942).

ment is fair, since these activities are especially weak and the thresholds difficult to determine. Selenium also shows a 57-minute activity, isomeric with the 17-minute period. Analysis of decay curves taken at a sequence of energies indicates that the 57-minute threshold is higher than the 17-minute. A similar analysis indicates that the 24.5-minute Ag^{106} has a threshold 0.25 M.E.V. higher than Ag^{108}.

The errors given arise from two sources: (1) uncertainty in energy settings, usually not greater than 2%, and (2) low ratio of activity to counter background near threshold, which makes estimation of a lower limit difficult. For this reason, the values given must be considered upper limits for the true binding energy.

VITA

George Curriden Baldwin was born May 5, 1917 in Denver, Colorado. He attended the elementary schools of Denver, Colorado and Oklahoma City, Oklahoma and the high schools of Salt Lake City, Utah. He attended Westminster Junior College, the University of Utah, and Kalamazoo College, receiving the Bachelor of Arts degree from the latter in 1939. From 1939 to the present time he has attended the University of Illinois, where he held a teaching assistantship during 1939-1941, a research assistantship during 1941-1942, and a fellowship during 1942-1943. He received the Master of Arts degree from the University of Illinois in 1941. He is affiliated with Sigma Xi, Phi Kappa Phi, Phi Beta Kappa, and the American Physical Society.

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